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BREEDING BIOLOGY OF THE INDIAN REEF HERON[1]

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(*With five plates and a text-figure*)

The breeding biology and nesting requirements of many heron species have been studied in several countries. The breeding biology of the Grey Heron, *Ardea cinerea*, has been studied by Verwey (1930), Lowe (1954), Owen (1960), Milstein *et al.* (1970); of the Purple Heron, *Ardea purpurea*, by Steinfatt (1939), Owen and Phillips (1956) and Tomlinson (1974a, 1974b, 1975); of the Great Blue Heron, *Ardea herodias*, by Vermeer (1969), Pratt (1970, 1972), Werschkul *et al.* (1977), and of the Great, White or Large Egret, *Ardea alba*, by Teal (1965), Pratt (1970, 1972), Maxwell & Kale (1977). The Green Heron, *Butorides virescens* has been studied by Dickerman & Gavino (1969) and Boat-billed Heron, *Cochlearius cochlearius* by Dickerman and Juarez (1971). The breeding biology of Cattle Egret, *Bubulcus ibis*, has been studied by several investigators (Skead 1966, Lowe-McConnell 1967, Blaker 1969, Jenni 1969, Dusi and Dusi 1970, Lancaster 1970, Siegfried 1972, Weber 1975, Maxwell and Kale 1977). The other herons that have been studied are the Little Egret, *Egretta garzetta* by Voisin (1976, 1977, 1979), and Night Heron *Nycticorax nycticorax* by Nickel (1966) and Voisin (1970). However, there is very little information available about breeding biology of the reef herons. A brief account of the interbreeding between colour phases and the timing of breeding season of the Indian Reef Heron, *Egretta gularis* (Bosc), now considered by Hancock and Kushlan (1984) as *E. garzetta schistacea* is given by Naik *et al.* (1981). The breeding biology of the Indian Reef Heron described in this paper forms a part of our detailed studies on the biology of the bird.

Material and Methods

The study was made mainly at the Gogha and New Port heronries, described earlier by Naik and Parasharya (1987), from February to

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June, 1980. The nesting trees were numbered and a large number of nests were individually marked by numbered plates during the nest-building stage. The nests were checked by climbing the tree. The freshly laid eggs were numbered with a felt-tipped pen, measured with Vernier calipers and weighed to the nearest 0.5 g with a Pesola spring-balance.

The nests were checked every day during the laying period, at four or five-day intervals during the incubation and hatching periods and at weekly intervals from the time chicks hatched, till they reached the age of 24 days. At other times, the observations were made from the ground, using 10× binoculars.

Results and Discussion

Nesting season:

The nesting season of 1980 started in early February—the earliest nests were started on 10th in New Port and on the 5th in Gogha. The season terminated in September, the last chicks having left their nests on the 10th at New Port and on the 13th at Gogha. The nesting was at its peak in April.

Colony Development:

The herons were thinly distributed along the coast during non-breeding season; they even wandered inland so that one or two reef herons were seen at almost every inland reservoir. They, however, converged towards their traditional nesting sites closer to the coast during the breeding season.

During the non-breeding season, the reef herons of New Port left the roost in the morning around sunrise, and returned to the roost only around sunset; between sunrise and sunset, they did not visit the roosting trees even during high tide. With the approach of the nesting season, an increasing number (Fig. 1) of reef herons started roosting on the same trees on which they eventually nested. Our observations on the heronries elsewhere in Gujarat indicate that the herons did not always use the roosting trees for nesting. Apparently, the roosting trees were also used for nesting wherever the trees provided safety and the nearby feeding grounds assured ample food supply throughout the nesting season.

As the nesting season approached closer, a few birds delayed their departure from roosting trees in the morning, if it was around high tide time. Similarly, they started arriving at roost earlier than their normal time, if the high tide occurred in the evening. The birds did not remain in their colony during the low tide hours. In an initial stage, there were only a few such birds and they were not very noisy. After a few days, more and more of them remained on the colony during daylight hours, and their vocalization during territorial and courtship displays made the colony noisy. Though almost all the birds had fully developed plumes, colour of the soft parts did not change in all of them. The number of birds with nuptial colour on their soft parts increased as the colony developed. A detailed account on the soft part colour changes associated with nesting is given by Parasharya and Naik (1987).

The first nest at Gogha in 1980 was built on a tamarind tree on which the Painted Stork (*Mycteria leucocephala*) still had grown chicks. There were two nests of the herons in an initial stage of nest-construction on 6 February, 1980. At this time, the birds left the nest sites unguarded when they foraged during low tide. But when intensive nest-building started a few days later, at least one bird per nest always remained at the site. The first eggs appeared in nests on 17 February. Timings of main nesting events at the Gogha colony during 1980 were as follows:

3 February: first reef heron observed at a nesting site

5 February: first copulation observed

17 February: first egg laid
Between 13 and 15 March: first chick hatched
Between 15 and 23 August: last egg laid

Nest and nest-building

At the Gogha colony, only a few old nests of the herons had remained on the trees at the approach of nesting season in February, but at the New Port colony there were many old nests available at the start of nesting season. The herons readily occupied the old nests, repaired them and laid eggs, though in several cases the old nests were dismantled and transported piece by piece to make new nests elsewhere. There were 16 old nests of the Painted Stork at Gogha when the herons started nesting and the herons dismantled them within a month and a half to re-use the material for their nesting. Similarly, material from an old nest of the House Crow (*Corvus splendens*) was also re-used. During the second nesting peak in July, old nests of the heron

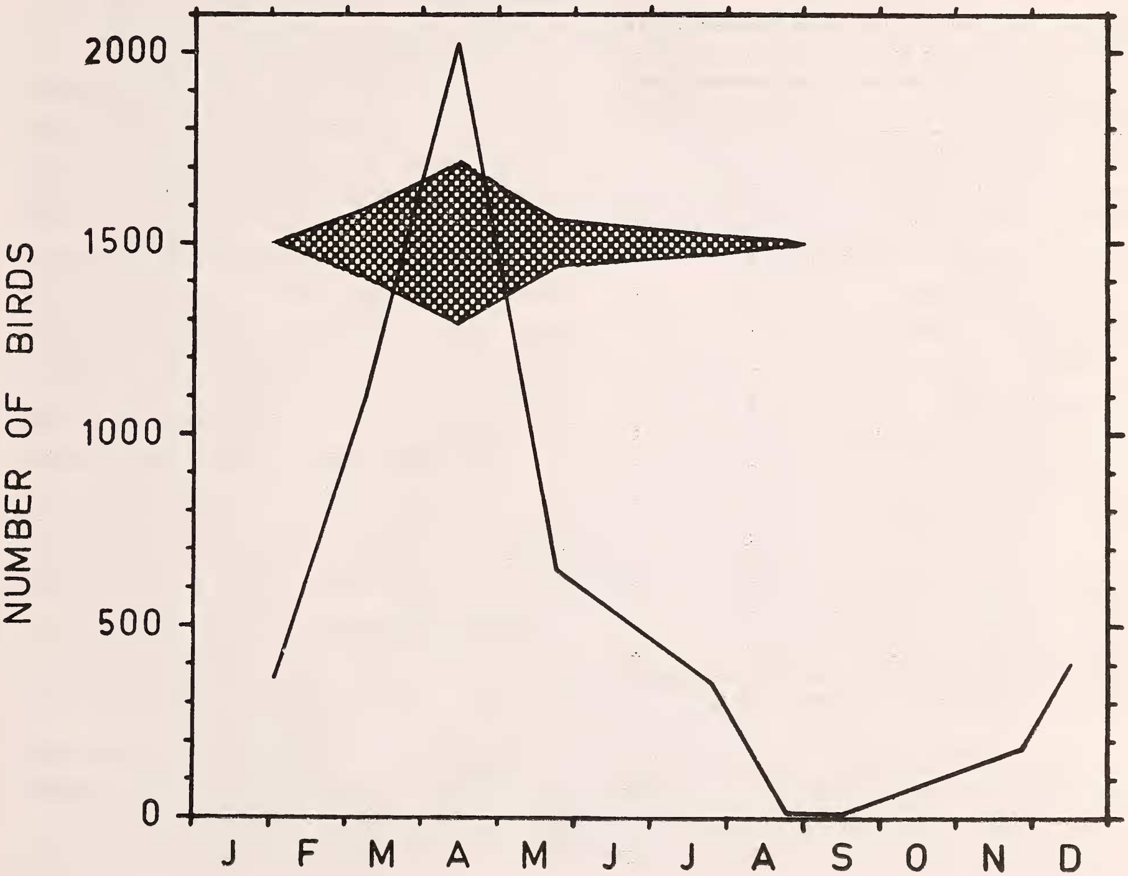


Fig. 1. The number of Indian Reef Heron roosting in relation to the timing of breeding season at New Port. The curve shows the number of birds roosting on different dates. The area covered by crossing lines indicate the proportion of pairs engaged in nesting activities (nest-building, incubation and feeding chicks).

were existing at both the heronries and the herons readily used them. At Gogha, an old nest of the House Crow was also occupied after repair.

The nests were usually placed in the vertical forks of three to four branches on the outer periphery of the tree crown. There was no foliage cover over many of the nests. In April and May, when the leaves of the Peepul and Peeper trees (Table 1) were shed, all the nests were almost totally exposed to the sky. Number of nests per tree depended upon number of branch forks available on the tree. On a big Peepul tree more than a hundred nests were accomodated, as there were many branch forks available for nest-building.

TABLE 1

DIFFERENT TREE SPECIES USED FOR NESTING BY THE INDIAN REEF HERON AT NEW PORT AND GOGHA

Plant species	New Port[1]	Gogha[1]
Albizzia lebbek, Lebbeck-tree	x	x
Avicennia marina, Mangrove	x	
Azadirachta indica, Neem	x	x
Casuarina equisetifolia, Casuarina	x	
Ficus amplissima, Peeper	x	x
Ficus benghalensis, Banyan	x	
Ficus racemosa, Cluster Fig	x	
Ficus religiosa, Peepul	x	x
Mimusops elengi, Spanish-cherry		x
Prosopis juliflora, Mesquite	x	x
Sapindus laurifolis, Soapnut		x
Syzygium cumini, Jambul	x	
Tamarindus indica, Tamarind	x	x
Thespesia populnea, Portia tree	x	
Zizyphus mauritiana, Jujube	x	x

[1] Use of a tree species is marked with x.

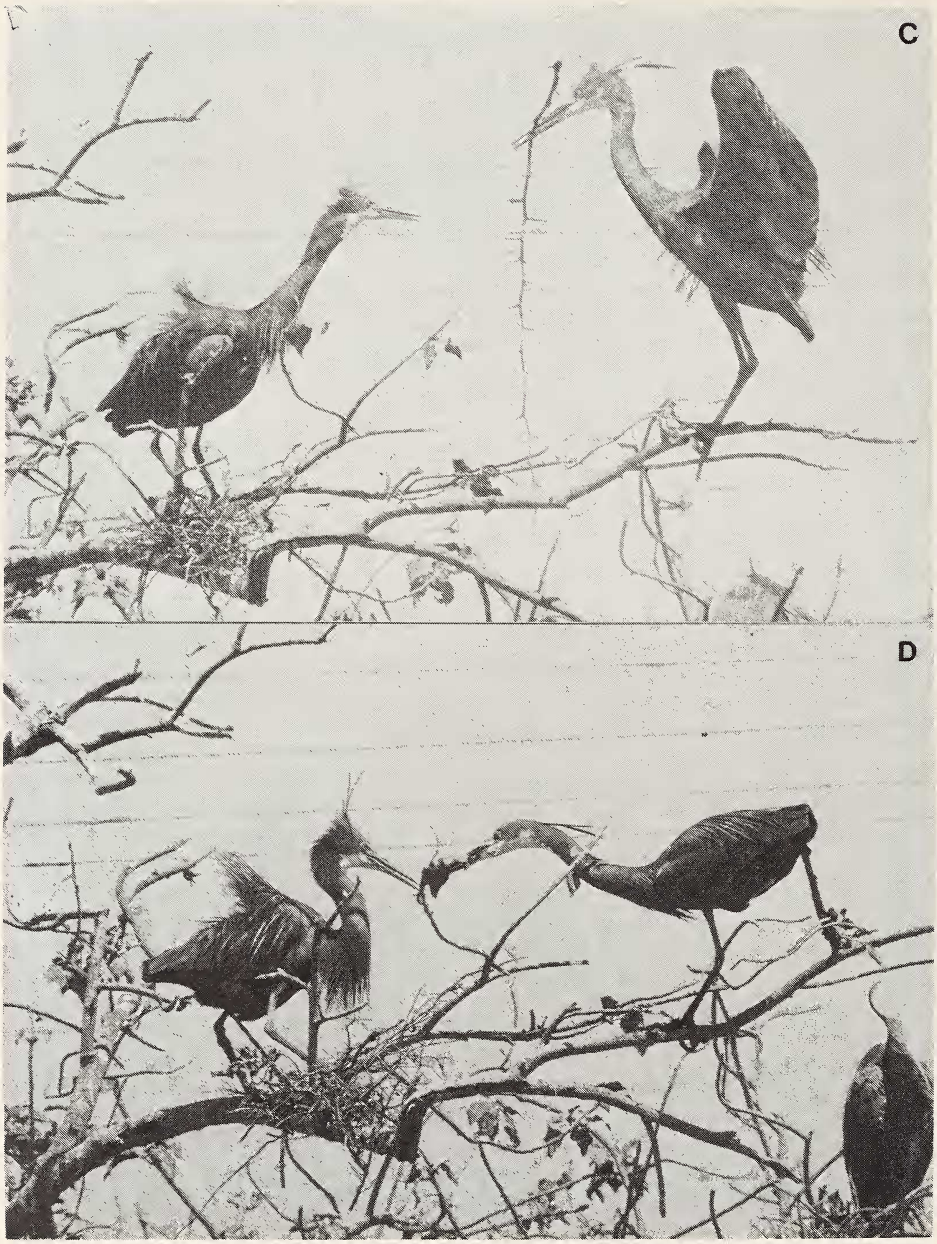
In a few nesting pairs where the sexes of the birds were known, the nest material was collected by the male and actual building was done by the female. Similar observations are reported by Ali and Ripley (1968). Such a division of labour during nest building has also been recorded in the Little Blue Heron, *Florida caerulea* (Meanly 1955); Cattle Egret (Blaker 1969); Indian Pond Heron, *Ardeola grayii* (Lamba 1963) and Night Heron (Ali and Ripley 1968), Blaker (1969) thought that the system of division of labour might have arisen so that the nest could be permanently guarded.

The nests were platform type, built mainly of dry and brittle sticks ranging from 12 to 66 cm length. Green twigs and pliable twigs were occasionally used. Generally, the nest material was collected from open ground nearby, but occasionally the bird pulled out branches from the nesting tree itself (Plate 1, A) or a neighbouring tree (Plate 1, B). One nest from Gogha analysed in August, 1980, comprised of 210 twigs mainly of the Peeper (*Ficus amplissima*), Neem (*Azadirachta indica*), Jharber (*Zizyphus nummularia*), Caper (*Capparis decidua*), Rusty shield-bearer (*Peltophorum pterocarpus*), Sickle senna (*Cassia tora*) and some grasses. The nests were usually lined with small twigs. Contrary to the Gogha nests, the New Port nests were chiefly constructed of thorny twigs and dry branches of Seepweed (*Suaeda nudiflora*) and in some cases, eggs were laid without lining the nests.

Mean measurements of eight nests at New Port in 1982 were: outer diameter about 35 cm, inner diameter about 18 cm and depth about 4 cm.

The addition of nest material continued throughout the incubation period, but stopped almost completely when the chick hatched, as Blaker (1969) observed for the Cattle Egret. In two cases, the nest material was added even after the chicks hatched. Pratt (1970) also observed occasional twig presentation in the Great Heron after a part of the clutch had hatched.

The reef heron collects nesting material from the nesting tree itself (A), or from a neighbouring tree (B). (*Photos:* authors)



Male reef heron returns with nesting material (C), and presents it to the female (D).
(*Photos:* authors)

After selecting a nesting site, the pair remained perched there for a few hours courting each other. Ultimately copulation occurred right there. After the male dismounted, both the birds held a small nearby branch and shook it vigorously. Thereafter, the female remained perched on the site and the male flew off to collect nest material. The male returned with a twig (Plate 2, C) and greeting ceremony followed. The male presented the twig to the female (Plate 2, D), which tried to arrange it on the branch fork, but the first few twigs fell to the ground. Sometimes, a pair could not arrange a few twigs on the site even after 24 hours of effort. Later on, the twigs were arranged criss-cross in the fork by shaking the twigs sideways ("Tremble shoving" — see Meyerriecks 1960) and by pulling and pushing them. As soon as the platform was prepared, some small thin twigs were added to it as lining material. During nest building, a considerable amount of nest material fell out of the nest, and occasionally the bird flew down to collect material lying under the nesting tree.

Intraspecific stick stealing from an unguarded nest was observed in many cases. The stick stealing birds could dismantle an unguarded nest within a day or two, and they even ejected the eggs or chicks in the process. Chances of losing nest-material from a nest increased progressively during the nesting period when the nesting pair started leaving the nest unguarded over a longer period. In one case at Gogha, a nest-building pair attacked the chicks in an unguarded nest and started pushing them away. After several attempts, the pair succeeded in driving away the chicks and occupying the nest, in which after an addition of a little more material, the pair raised its own brood successfully. The chicks which were evicted from the nest remained perched on nearby branches and they were fed there by their parents until they fledged. Intra-specific stealing of nest material was observed for Cattle Egret by Valentine (1958) and Blaker (1969) for the Great Blue Heron by Pratt (1972) and Mock (1976), and for the Great White Egret by Mock (1978).

The nests were built at a height of about 5 to 15 m from the ground at Gogha, but some nests were built even at the height of about 2 m from the ground at New Port. The species of trees used for nesting in Gogha and New Port are given in Table 1.

Eggs and incubation

Egg laying:

Generally the eggs were laid at an interval of two days, but in two cases the interval was longer than three days. In this connection, a case history of one particular nest is worth noting. The first egg was laid on 29 February, and the second on 2 March. On 5 March, a third freshly laid egg was found, but the first two eggs were missing. On 14 March, when the nest was checked, the third egg was missing but two new eggs were added in the nest. Again on 25 March, when the nest was checked two more eggs were found, so that there were now four eggs in the nest. Including the loss of three eggs earlier, the bird laid a total of seven eggs during an 18-day period. It is possible that, after having lost all the eggs of the first clutch started on 29 February, the bird started a fresh clutch around 12 March; this speculation is based on the observation that the two eggs found on 14 March were fresh in appearance.

Incubation:

The first egg was laid within 4 to 7 days after the initiation of nest-building. As in all Ardeidae (Kendeigh 1952), the incubation began with the laying of the first egg. Once the eggs were laid, the nest was never left unattended in summer except during a big disturbance. In monsoon, however, the birds often left the nest unguarded (Plate 3, E) even if there was no disturbance. Incubation period (interval between the laying and hatching) of only two eggs was precisely known and it was 23 and 24 days.

Both the sexes participated in incubation. Generally, there were three change-overs of duty within 12 hours of the daytime, but occasionally there was only one change-over in the morning for the whole day. The duration of the attentive period varied between 2 and 8.5 hours. Both the sexes attended the nest and their average attentive period had about the same duration. The nest was attended at night by any one sex. In one case, a bird covered the eggs continuously from 1200 to the next morning, which added up to more than 20 hours of nest attendance.

Clutch and egg size:

Clutch size is defined here as the total number of eggs known to have been laid in a nest in an uninterrupted series. The clutches of 3 and 4 eggs were most usual (as also stated by Ali and Ripley 1968) but occasionally a clutch of 6 was also laid. Our data on the size of 28 clutches are summarised in Table 2.

Fresh weight (weighed within 24 hours of laying) of 22 eggs and dimensions of 88 eggs are summarised in Table 2. Baker (as quoted by Ali and Ripley 1968) measured 50 eggs and reported the average size as 44.9 × 34.3 mm which was close to our measurement.

Egg mortality:

Falling out of the nest was the main cause of egg loss. In certain cases, the heron started laying even when the nest platform was not completed. In such nests, a heavy egg loss occurred during the laying period. Occasionally, when an observer climbed a nesting tree for nest-checking, the birds left their nests in a hurry, shaking the branches supporting nests, and this, in turn, caused eggs to fall out of the nests. During such a disturbance, the House Crow did not miss a chance to take away the eggs. This predator tried to take away the eggs and small chicks at other times too, when the nest was unattended. During May to July, very high winds in the afternoon and evening also caused egg-fall. Intraspecific nest-material stealing activities were also a factor for egg mortality. The White Ibis, in an attempt to appropriate some active nests of the reef heron,

TABLE 2

CLUTCH SIZE AND EGG SIZE OF THE INDIAN REEF HERON AT GOGHA, SUMMER 1980

Clutch size[1]			Egg size[2]		
Size	Frequency		length mm	width mm	weight g
3	10	Range	41.5 to 50.2	30.4 to 35.7	23.0 to 31.5
4	16		(88)	(88)	(22)
5	0	Mean	45.61	32.97	28.39
6	2	s. d.	2.030	1.069	2.262

[1] Mean clutch size ± s.d. = 3.8 ± 0.79 (for clutches).

[2] Numbers in parentheses indicate the number of eggs measured.

destroyed the herons' eggs and chicks at New Port.

Chicks

Hatching:

Chicks hatched asynchronously. The eyes of the chick were open and the body covered with down at hatching. The down dried up within a few hours. The empty egg shell was ejected out of the nest by the attending parent.

Mortality:

The chicks of 18 days or more were left unguarded by the parents. The chicks roamed out of the nest after the age of 24 days, so that it became difficult to determine as to which nest they belonged to, and in many cases the fate of nestlings after 24 days could not be recorded. Therefore, 24 days was considered as the nestling period, at the end of which the chicks were considered to have fledged. Mortality rate decreased after the chicks fledged, as only a few fledged chicks died before they left the colony. Such deaths were chiefly due to a fall from the nesting tree.

Predation by the House Crow was one of the major factors leading to chick mortality, particularly during early (less than 10 days) age. Chicks older than 18 days, which usually wandered out of the nest, often lost their balance, fell to the ground and died. They often went too close to the neighbouring nests, where the attending parents did not tolerate their trespassing and tried to stab them. During such encounters, the chicks got injured, often lost their balance and fell to the ground. On being frightened by a human climbing a tree, the chicks tried to run away and fell to the ground.

Mortality of chicks due to starvation did not appear to be significant during an earlier part of the season; 7 broods, each one of 3 chicks, were reared without any chick loss and in one case four chicks were reared without a loss. But during the later part of the season, the younger chick in many broods died due to starvation. Except for the House Crow, no other avian predator was observed in the colony. The domestic cat was reported to climb nesting trees and kill the chicks at night at New Port.

The chicks which accidentally fell to the ground generally died due to the fall. Even if they survived, they could not climb back to their nests. Such chicks were then killed by domestic dogs.

Chicks also fell out of the nests when heavy wind, storm or rain prevailed. Some chicks were found hanging dead from the nest rim after a heavy wind had blown. Some chicks died because one of their legs got trapped in a narrow branch fork.

Asynchronous hatching:

In a usual brood of three chicks, two older ones were very big as compared to the youngest. The youngest chick apparently stopped growing for a long time and remained in the nest even when the older ones were roaming around the nesting tree. This difference in the growth of chicks was due to their asynchronous hatching. The eggs hatched in the sequence in which they were laid. Therefore, the age difference between the eldest and youngest chicks in a brood was quite often more than five days. The parents fed the older chicks which begged violently; the younger chicks got less food, they remained smaller for a long time and sometimes even died due to starvation.

Parental care

Guarding the nest:

At least one parent actively guarded the chicks (Plate 3, F) till they attained the age of about 18 days (average for five nests). After that, a parent took up a perch some distance away from the nest and guarded the chicks for a further period of two to five days. Thereafter, the chicks were left unguarded, and the parents returned to the nests only to feed them and to roost with them at night.

The full "Forward display" was directed by an adult bird towards a predator, a conspecific perching very close to the nest or even a human intruder. If the crow was very close, the guarding bird might stab towards it. When an observer climbed a nesting tree for nest-checking, the adult birds flew over to branches further away, and kept an eye on the observer from there. Often they produced a short "Kok-kok" alarm call and maintained an alert posture. Only in a few cases did the guarding bird not leave the nest and violently attacked the observer's hand when he tried to pick up chicks from the nest.

A guarding adult did not permit any heron other than its family to perch close to its nest. An intruder was threatened with the Forward display, or even chased some distance away. In one case, a guarding bird was threatening a courting pair perching very close to its nest, when a guarding bird from another nearby nest rushed to the courting pair and chased it away. Trespassing neighbour-chicks were also attacked and stabbed on their head. Chicks which accidentally fell on the ground were not cared for by the parents.

Thermoregulation:

Generally the herons incubated the eggs or brooded the chicks by sitting on them. The sitting bird kept its feathers fully depressed (Plate 3, G) or partially raised to conserve its body heat and kept them fully raised (Plate 4, H) for passage of air for dissipating the heat. The incubating bird might keep its neck straight, let the head rest on the nest rim and doze off from time to time.

The chicks were highly susceptible to direct radiation from the sun, especially when the ambient temperature rose up to 42°C in April/May, and there was a special need to prevent the chicks from getting over-heated. Assuming a posture very similar to the Delta-wing posture of the storks (Kahl 1971), the reef heron kept its wings in a drooping position, kept its back towards the sun and shaded the chicks with the wing canopy (Plate 4, I) During the hot hours, almost all the guarding birds in a colony could be found facing the same direction. The direction of the guarding bird changed with the position of sun. In April-May, this directional thermoregulation started right at 0900 and could be seen till 1700. The parents shading the chicks stood on the rim of the nest, often keeping the legs flexed (Plate 4, J). The back feathers were often raised. The beak remained open and gular fluttering continued (Plate 4, K). The chicks kept themselves under the parent's shade, often touching the parent's body. Blaker (1969) did not find any special shade-providing position in the Cattle Egret, but Jenni (1969) has reported it in the Cattle Egret as well as in a few other species of herons.

The adult birds started gular fluttering from 0900 and continued till 1830 in April-May. As the adult birds were also susceptible to the sun's heat, it seemed that the wing posture had not only the function of shading the chicks, but also gave passage to the wind to pass through and helped the bird in self-thermoregulation. Kahl (1971) suggested that it is probable that the function of shading the nest contents is often combined with self-thermoregulation in birds adopting the spread-wing posture over eggs or young in hot weather.

One-day old chicks had the gular fluttering ability. Though brooded and shaded by the

The reef heron's eggs are occasionally left unattended in monsoon (E), but the small chicks are always attended to (F), and are brooded from time to time (G).
(*Photos:* authors)

The reef heron, while shading its eggs and chicks from solar radiation, often raises its feathers fully (H), and resorts to gular fluttering (I), to dissipate its own body heat; by spreading its wings partially the bird forms a canopy (J, K) over its brood and at the same time dissipates its own body heat. (*Photos:* authors)